ANSWERS to Crystal ball questions on Conjugate acid/base pairs

1) Conjugate acid/base pairs are two species that differ in their structure by a single proton (H^+). In this reaction illustrating the self ionisation of water, one water molecule donates a proton (H^+) to the other. The proton donor molecule is the acid (one of the H_2O molecules) and its conjugate base is OH^-. Another conjugate acid/base pair is H_2O as the base and H_3O^+ as its conjugate acid.

2) Amphiprotic means a substance can either donate or accept protons (H^+ ions). Common examples of amphiprotic substances are a water molecule (H_2O) and the hydrogen sulfate ion (HSO_4^-)

eg water acting as a base, so gaining a proton when reacting with HCl

$H_2O\ (l) + HCl\ (aq) \rightarrow H_3O^+\ (aq) + Cl^-\ (aq)$

and acting as an acid when reacting with a base

$H_2O\ (l) + NH_3\ (aq) \rightarrow NH_4^+\ (aq) + OH^-\ (aq)$

eg the hydrogen sulfate ion acting as an acid

$HSO_4^-\ (aq) + OH^-\ (aq) \rightarrow SO_4^{2-}\ (aq) + H_2O\ (l)$

and the hydrogen sulfate ion acting as a base

$HSO_4^-\ (aq) + H^+\ (aq) \rightarrow H_2SO_4\ (aq)$

3) When sodium ethanoate dissolves in water it ionises

$CH_3COONa\ (s) \rightarrow CH_3COO^- + Na^+$

Water reacts with the ethanoate ion to form ethanoic acid

$CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$

In the equation above, the H_2O acts as an acid donating a proton to the ethanoate ion, so the conjugate base of water is OH^-.

So the solution of sodium ethanoate is basic as the OH^- ions cause the pH to be above 7.

4) i) The acidic ion is $H_2PO_4^-$ and its conjugate base is HPO_4^{2-}

$$H_2PO_4^-(aq) \rightleftharpoons H^+(aq) + HPO_4^{2-}(aq)$$

ii) When a small amount of a strong base (OH-) is added to this buffer solutions the OH^- is replaced by a weak base, so the effect of the strong base is minimised.

When a small amount of a strong base is added to a buffer, the OH^- reacts with the acidic part of the buffer to give more of the basic part of the buffer.
The strong base reacts with the acid of the buffer (H_2PO_4-)

$$OH^-(aq) + H_2PO_4^-(aq) \rightarrow H_2O(l) + HPO_4^{2-}(aq)$$

When a small amount of a strong acid such as HCl is added to a buffer, the H^+ from the acid reacts with the basic part of the buffer to give more of the acidic part of the buffer.

$$H^+(aq) + HPO_4^{2-}(aq) \rightarrow H_2PO_4^-(aq)$$